Experimental Physics I
Prof. Amal Kumar Das
Department of Physics
Indian Institute of Technology, Kharagpur

Lecture – 04
Basic tools and apparatus (Contd.)

So in last lectures, I was discussing about the slide calipers.

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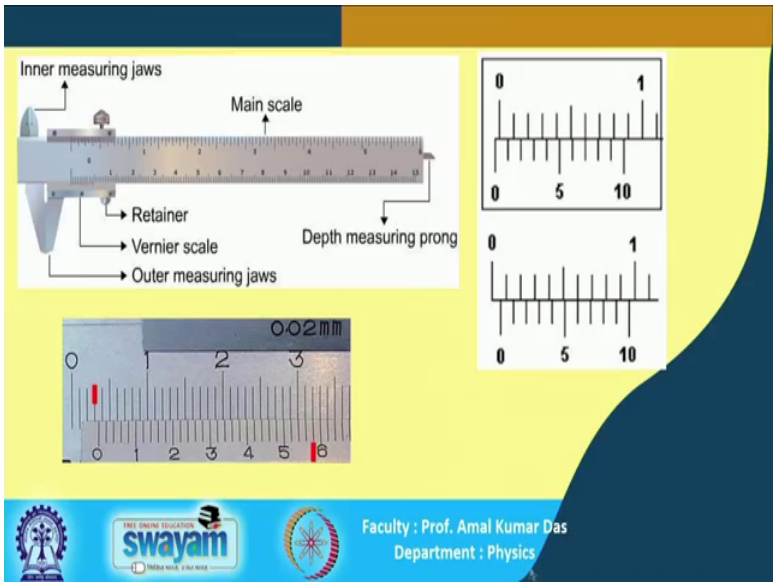

So basically, what we have discussed that that slide calipers have mainly these 3 parts, which are very useful. So, this upper jaws is called basically inner measuring jaws, then this one is called the outer measuring jaws and this tail. It is called the depth measuring prong or tail and then this is the main scale and this is the vernier scale, this is retainer as I showed that to tighten it at a particular place. So, we to retain it basically we use it and this is the vernier scale. So, that we have I have shown you and then I have discuss about the about the zero error. So, as zero of the vernier, if it coincide with the 0 of the main scale then zero error is nil and if zero of the vernier is at the left of the main scale 0, then we tell this negative error ok.

So, what is the value of this error? So, that we have to see this which division of vernier scale is coincide with the main scale ok. So, here you can see the seventh vernier division that this line coincides with this main scale line. So, this error negative error will be minus 7 into vernier constant. So, if vernier constant it is 0.01 so, then it will be 0.07

minus 0.07 centimeters that is the error and it is a negative error and if vernier constant is 0.002 then that will be here it is of course, because 10 divisions are there. So, it is the 0.01 centimeter is the vernier constant but, other case here.

So, this here this vernier constant is 0.002. So, one has to find out the zero errors depending on the coincidence of the one division of a vernier scale with the scale line ok. So, this one for this is the negative error and this one is positive error ok, because 0 vernier scale is at the right of the 0 of the main scale ok.

So here, I think which line coincide. So, this sixth line of sixth division was sixth line of vernier scale coincided with the with the main scale line. So, vernier so, zero error is basically 6 into 0.01 centimeter. So, that is 0.06 centimeter and this is plus 0.06 centimeter. So, that is the zero error and yeah if we ask you this what is the reading in this case? Ok what is the reading?

So, then you have to find out what is the main scale reading as I told that, which will be the main scale reading? No this just at the left of this 0 of vernier scale. So, that is the main scale reading this line is just at the left of the vernier 0 ok. So, it is a 123 3 millimeters; that means, 0.3 centimeter that the main scale reading and what will be the vernier scale reading? So, vernier scale reading, we have to find out that is how many division here, which division or which line of vernier scale coincide with the main scale. So here, I think this one is the better or not this one or this one whatever I think here red mark is there. So, it is taken as a coincidence line ok.

So, but one can take this one also. So here so that is not the error bar error, you know plus minus this one least count that is taken as error. So, if I take this one. So, this one is I think this is 20, 21, 22, 23. No, this is a 5, I think 25, this one 25, 26, 27, 28, 29 ok. So, this is the 29th vernier line coincide with the main scale line. So, vernier reading is 29 vernier constant in this case is a 0.02 millimeter means 0.002 centimeter.

So, vernier scale reading will be 29 into this vernier constant. So, it will be 0. I think it will be 58 yes 0.058. So, that will be the vernier scale reading ok. So, total reading will be total reading will be 0.3 centimeters plus vernier scale reading 0.058 centimeter. So, total reading will be 0.358 centimeter ok.

Now, you have to take care of this zero error if any. So, then this reading minus that is will be taken final reading minus the initial reading, that is the zero error ok. So, in case of negative so, I have to minus of minus in this case, whatever we saw this I think 0.06, but here vernier constant is dependent this one. So, what I want to say so, this minus of minus this in zero error. So, it will be plus in this case minus or plus this reading. So, this will be actually minus. So, final reading minus or it will be in case of positive error, it will be minus of this zero error and in case of negative error; it will be plus of this zero error ok. So, that will be the final reading ok.

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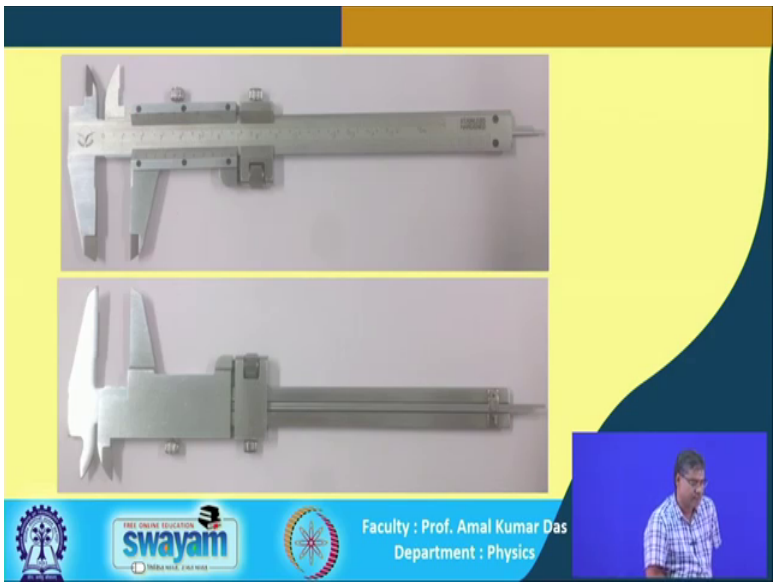

So, as I showed through this screw gauge has I have shown earlier. So, this screw gauge right.

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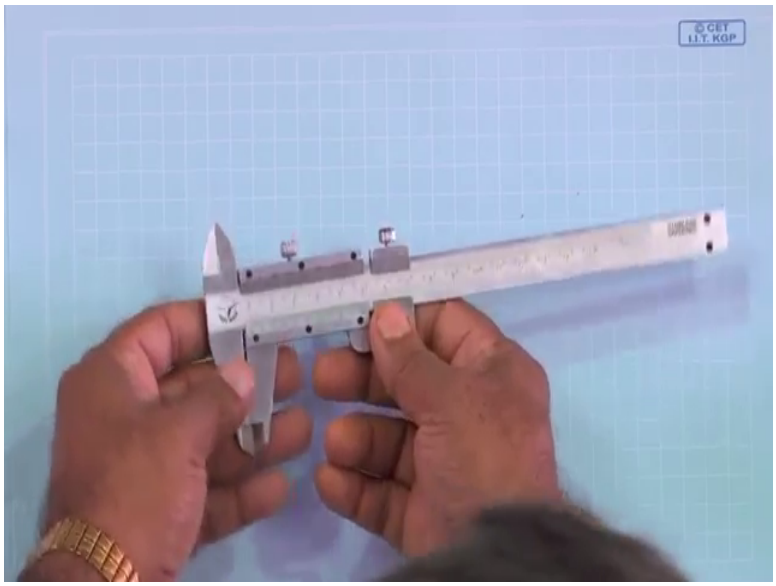

So, it has zero error it has it has no zero error as I showed you, it has no zero error right it has no zero error it has no zero error, it has no zero error ok. So, this is used for as I told this inner measuring jaw. So now, what is the use of that? So now, if I ask you what is the internal diameter of the cylinder?

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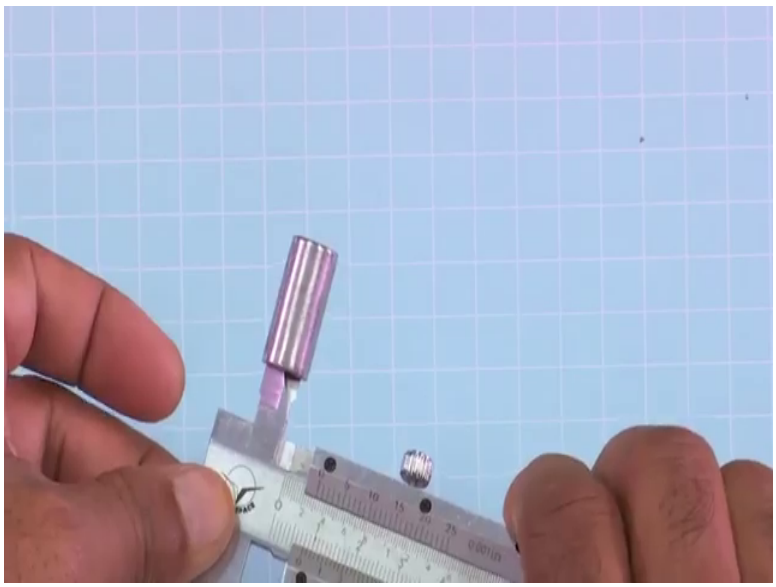

So, then this is the use of this one and this say so, this one ok. So, this is the inner diameter, you cannot measure inner diameter using this one, because this you see this is

for external, this is good for external as I describe you ok; this parallel this 2 edge of the jaw will be used for measuring right.

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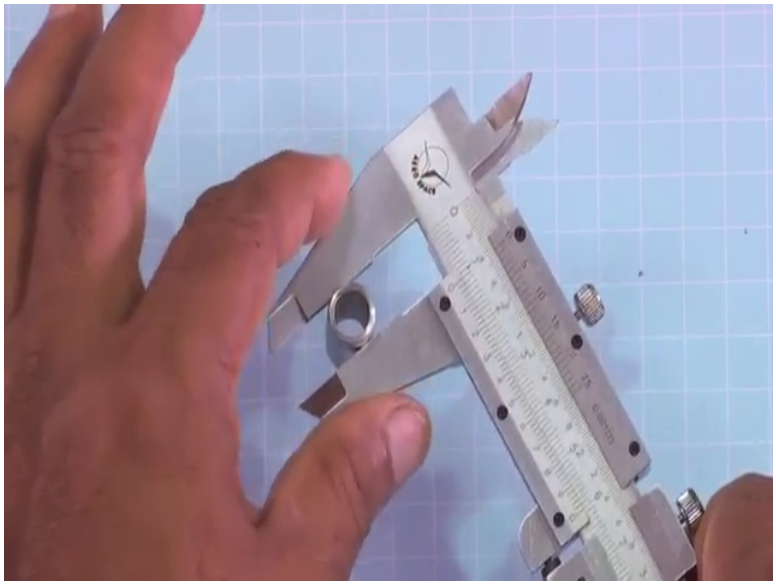

So, this is for measuring for external diameter this will be used for internal diameters ok. Now, if I ask you what is the depth of the cylinder? Then how we will measure, the depth of the cylinder?

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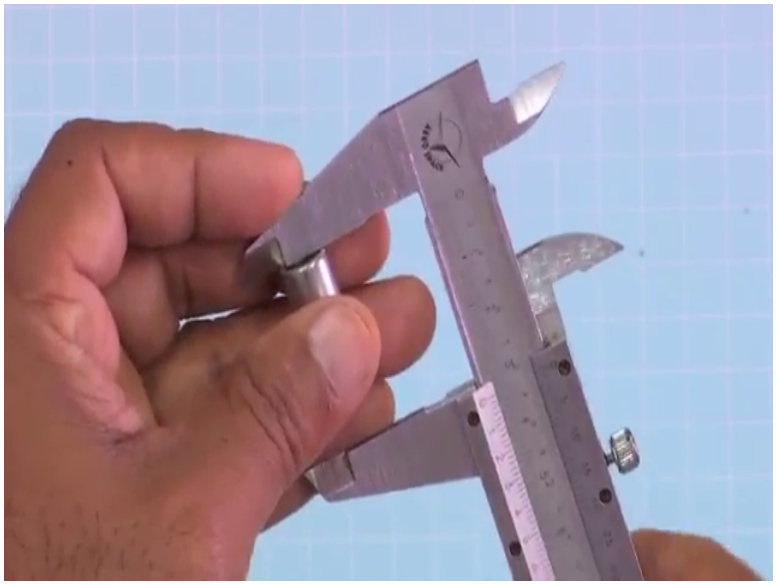

Here in this case is both end are open, but if 1 in this. So, then you can measure. So, this is a 1 can measure. So, because depth and this from this outer this length, this length and

depth are same, but imagine if this one end is closed and it has some thickness ok. So, then external this length is not same as the depth of that one so, in that case to measure the depth.

(Refer Slide Time: 11:09)

So, basically it is this other part is used this tail or prong is used ok. So, this part so this, basically this way ok. So, this basically you are using from measuring depth. So, what is the reading? One has to find out, what is the reading? One has to find out ok.

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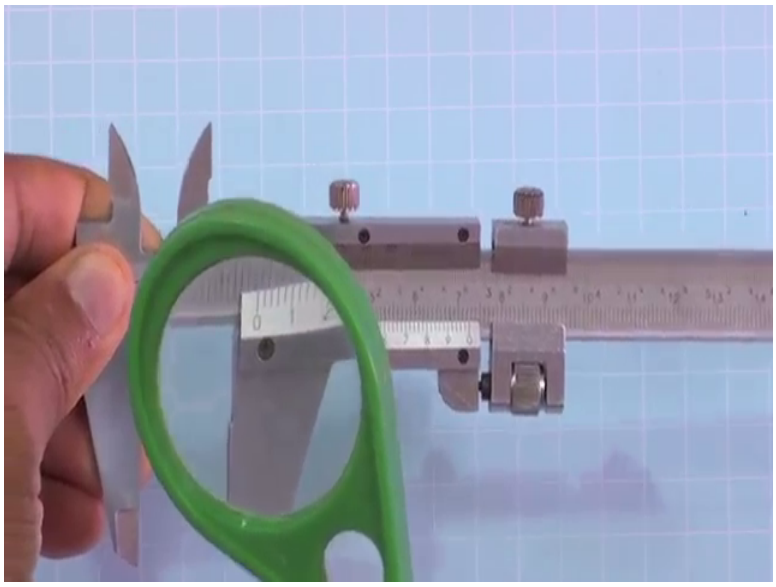

So, it is not difficult to find out here is you can I can see 1, 2 centimeter and then 2 then 1, 2, 3. So, 2.3 centimeters and then after that this 0 vernier 0 and then I have to see how many division coincide with it. So, it is around 25 around 5 that there 5 means 35 division or 26 division or 27 division almost, it is coincide with the 27 division.

(Refer Slide Time: 12:17)

Here you see, it is coincide with the main scale division yeah. So, 27 one can take ok. So, 27 into this vernier constant so that that will be the vernier reading and so, main scale reading plus this vernier reading. So, that will be the final reading minus initial reading, it is a 0, because zero error is nil so that would be the depth ok.

So, this is the use for measuring the internal radius or diameter external diameter and this is depth of this cylinder ok. So, this slide calipers is very useful, which you cannot do with the meter scale except. So, this it is not only for the only for the lower least count better least count, but it is for other advantage also for using this slide calipers ok. So, then I think I will go yes.

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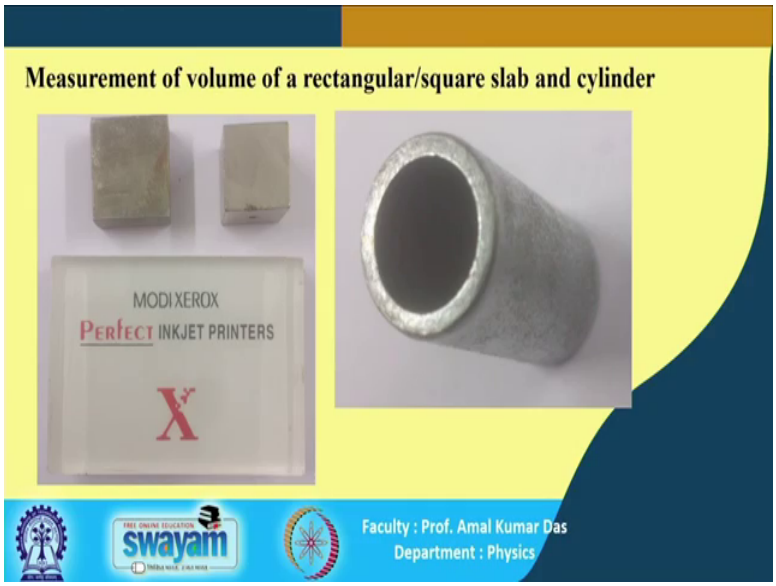

So, using this slide calipers one can measure the volume of be different regular shape also as I told you that this if you want to yeah of course, if you want to find out the volume of this cylinder also you can find out internal volume in internal volume external volume. So, whatever so that is possible because we have 2 measure the radius. So, from diameter, we can find out the radius and then use formula then we can measure ok.

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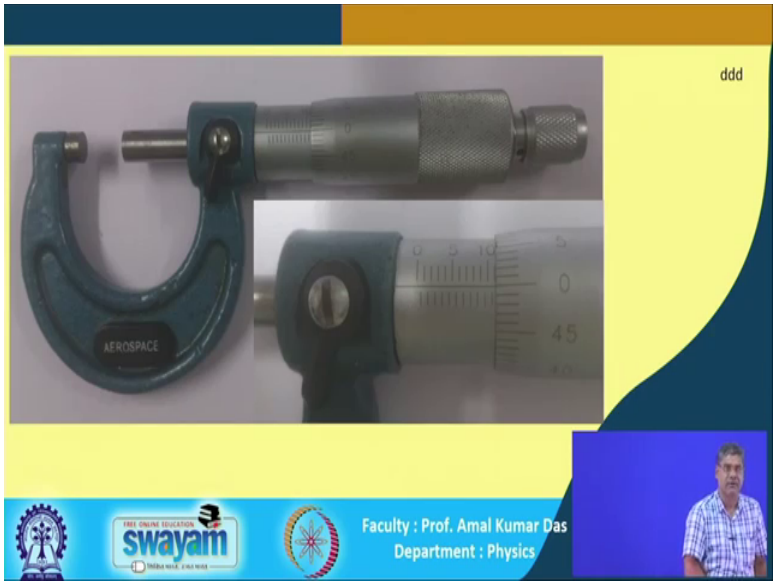

The next I will go for this screw gauge. So, another tools for measuring the length ok. So, that is the screw gauge.

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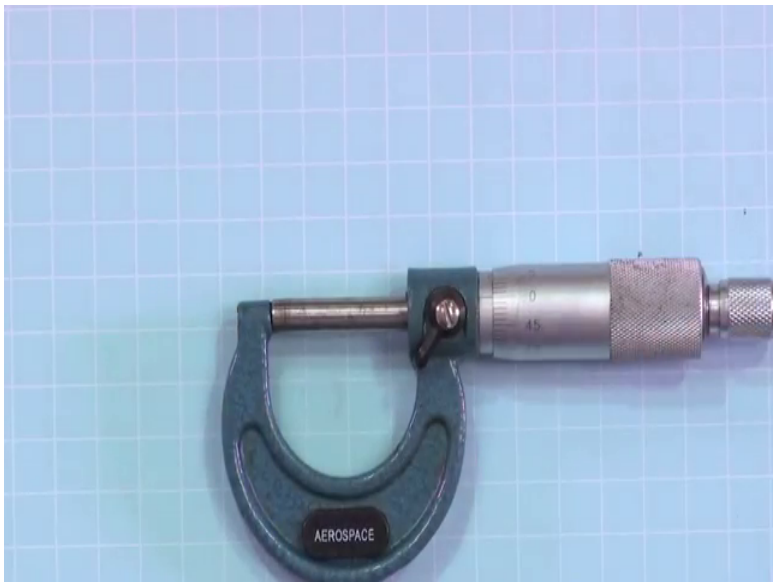

So, this is my screw gauge I think. So, so, this is screw gauge. So, screw gauge also used for measuring the measuring the length ok. So, this screw gauge again it is a least count is better than the slide calipers is the least count. So, in this case also you have to find out first, you have to the same way. So, I think.

(Refer Slide Time: 15:24)

So, first you have to check whether is there any zero error ok. So, in this is, what are the things? Ok.

So, here so whatever objects whatever the length of the object, you want to find out it can be diameter; it can be the thickness. So, it is this is used for very thin wire this for if a thin this thickness of plate ok. So, for those items or body we use the slide at this screw gauge. So, so that body is placed between these 2 parallel faces.

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So, what are the name of them? I will just tell you ok.

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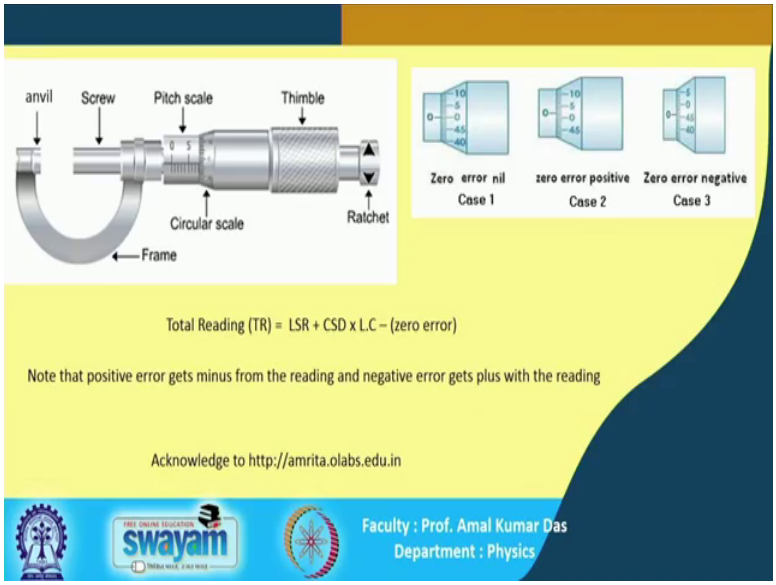

I think I can show you different parts. So, it is the. So, this part is I think this part is called anvil ok.

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This part is called screw ok.

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And this is called this here this basically, 2 scales are there one is circular scale, this circular scale ok. So, in this case, it is the it is 0, 1, 2, 3. So, up to in circular scale, this is total 50 divisions are there and then this is called these are main linear scale circular scale and linear scale. So, in linear scale this is the divisions are in millimeter, and so this is the circular scale ok.

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And this called ratchet, this is called ratchet ok. So, this helps to know that when you are putting anybody you need to measure the thickness are diameters of in wire. So, we put the things in your (Refer Time: 07:20) So, how long you should place? So, after just touching it, if you just use this one then it will just give a sound; that means, the end your you can stop this pressing ok; that means, this is the right position for this thickness of diameter and then you should take reading ok.

So, this is the instrument it is called screw gauge ok. So, here also here also basically here also basically, first one has to see the whether there is any zero error. Ok this case also this when if you just if you if these 2 just coincide touch each other. So, then in that in to say yeah so, then you have to see this yes the 0 mark on the circular scale, 0 mark on the circular scale ok.

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0 mark on the circular scale oh no, I think this 0 mark on the circular scale, whether it coincide with this linear line, whether it coincide with the linear line. So, it is seems it is it is I think is it is some mark is there yes I think yeah.

So, if it is this way ok. So, if it is like this you can see 0 mark on line on the circulars scale, it coincide with the main scale that or linear scale that mark then we tell this zero error is nil, but in this case, there is a error I can see. So, it is basically it is like this you see 0, 0 did not coincide with this linear I think this is a reflection.

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I should you can see you can see 0 is just cross this linear scale that mark and it has done just I think few division of. So, 0 of circular scale it cross this linear scale that mark ok.

So, this is one type of error, if it cross then we tell that is the, I think it cross means 0 it has it. So, it has cross. So, it will give some extra initial error, it will give some extra initial error ok. So, then whatever final reading will be there. So, that should be subtracted from there ok. So, then it is a basically positive error ok.

Now, if it does not cross it is just it could not reach to that scale that mark on linear scale. So, then it will be negative error because, it could not reach. So, these thick is 1 is zero error nil 1 is zero error nil. So, it coincide ok. So, this 0 line on the vernier circular scale, it coincides with the 0 line on the linear scale ok. So, this is a error this is nil and here you see oh ok.

So, I think that 0 could not reach to the vernier circular 0 could not reach to the 0 of the linear scale then it is a positive error and 0 0 of this one it cross the it cross the 0 of the linear scale then it is negative error

So, that is what I think earlier also we have described in same way right. So, in vernier scale also slide calipers also what we have? we have told that when 0 of the 0 of the vernier scale it, if it could not reach to the 0 then it is positive error, if it cross it ok. So, then it is negative error ok.

So, in this case also when you are rotating, when you are rotating the scale ok. So, when you are rotating and when this in this touch and then if it could not when the 0 of the circular scale, it could not reach to the 0 of the main scale then it is positive error, if it reach and then cross it then it is negative error. In meter scale also if you just initial reading, if it is more than 0 means it is that towards the, I think if it is towards the right ok. So, that will could not reach to 0 like this ok. So, it is a positive means just minus of this one, if it cross this 0 in main scale. So, then it will we have to add it with the so, that with final reading.

So, we have to add this initial reading that means, from definition final to final minus initial. So, that one has to be minus of this error so, minus of minus this initial reading. So, that will be plus ok.

So, this is the so, in this case in screws screw gauge also this you have to find out the zero error and that zero error is nil in this case zero error positive. In this case and zero error negative in this case and your reading total reading. Now here a linear scale reading so, it is the main scale reading in vernier we told main scale reading. So, here we tell linear scale reading and then plus circular scale reading, there we tell vernier scale reading; here we tell circular scale reading into least count LC. So, there vernier constant whatever you told that is the here it is the least count minus. So, this will be the final reading minus initial reading. So, that the zero error ok.

So, so now, I have to tell you how to find out the least count. So, this again this heres you see here first zero error after that after that here you see if I just rotate, if I just rotate, if I just rotate by 1 complete one circle. So, you can see you can see here it has come out this ok. So, I think 1 rotation, I have given I should give more than you can see the linear scale ok, 1 rotation I have given then 2 rotation then 3 rotation then 4 rotation then 5 rotation I am giving then 6 rotation, I am giving this 7 rotation I am giving. So, in 8 rotation, I am giving 9 rotation complete rotation and then 10 complete rotation.

So now, you see you can see the linear scale. So, 10 rotation complete rotation, I have given. So, in linear scale you say, what is the reading in linear scale ok. You can see reading in linear scale is basically, you can see it is 5 millimeter it is the 5 millimeter, whether you can see or not it is 5 millimeter. So, 10 complete rotation it is the 5 millimeters in linear scale. So, this gap it is a 5 millimeter ok.

So, so basically, now for one complete rotation what is what is the reading in linear scale. So, it will be 0.5 millimeter ok. So, that 0.5 millimeter is called the pitch it is called the pitch of the, it is called the pitch. So, for one complete rotation whatever the reading in linear scale this so, that is called the pitch ok. So, this least count is defined as least count is defined as here, I have not written ok. So, I think I have not written least count is defined as you know it is here I can show this least count is defined as the is the pitch of the screw gauge pitch of the screw gauge divided by total number of divisions of circular scale.

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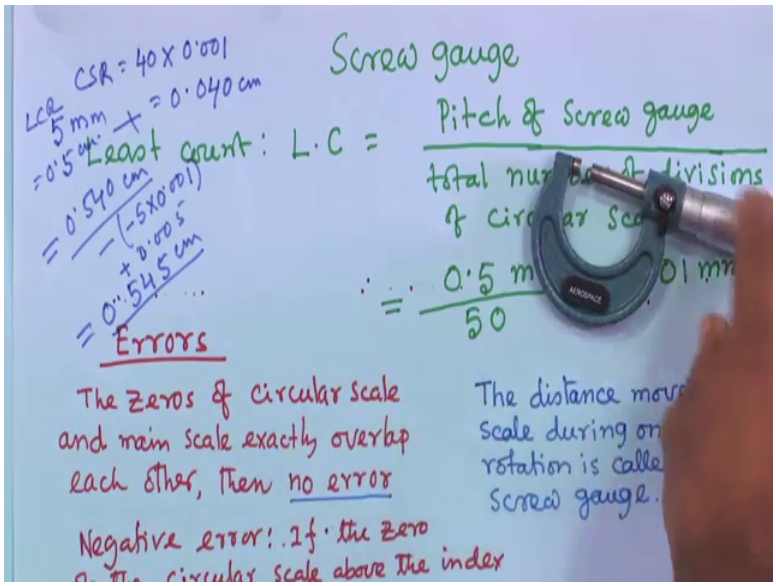

So, pitch of the screw gauge as I showed you the 0.5 millimeter and the total division in circular scale is the 50. So, you are getting this 0.01 millimeter; so, that is 0.01 centimeter ok.

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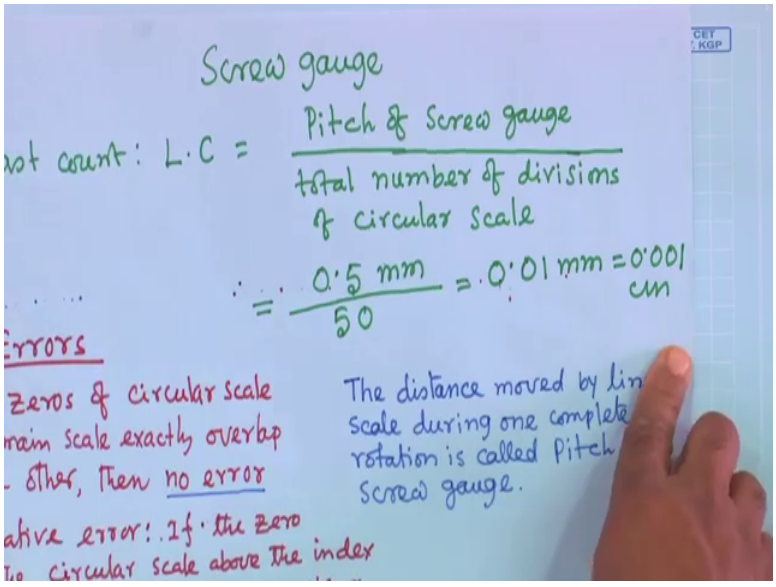

So, this is the least count. Now when we will measure so, taking reading also same here you have to find out the what is the reading in linear scale ok. So, in this case it is the as I (Refer Time: 29:18) that is a 10 division that in I just rotated by 10 so, but you will not

need to count. So, that will be given by this linear scale. So, it is the 5 millimeter and then some crossed some reading is you can find out so, this 0. So, it so, then you have to find out what is the reading actually this in linear scale that mark this mark. So, which line on the of the circular scale this coincide with this mark linear mark ok. So, that division you have to find out. So, here the division is yeah it is division is say it is in this case whatever it is just 40 ok.

So, 40 is the circular scale reading and least count is 0.001. So, it will be 0. There is a 40 0.040 ok. So, that is 0.40. So, that will be the circular scale reading and then linear scale reading is in this case 0. I think 0.5 millimeter means 0.5 centimeters and for 40 it has come 0. Oh that will be I think 0.00 40 40 into 0.001. So, it will be 0.04 0.04 no it is a 0. I have calculate so if I get circular scale reading circular scale reading this is a 40.

And then into vernier least count that is 0.001ok. So, that will give you 0. 0 I think 4 0 centimeters and your main scale reading was oh that was 5 millimeter sorry. So, that is not the problem. So, the linear scale reading was 5 millimeters. So, means 0.5 centimeter ok. So now, this plus this 2 will give you that 0.540 centimeter ok so, this will be the reading.

Now, this the as we told that is the we have to take this final reading minus the initial leading that error, if any error is there. So, in this case I told you some error was there. So, it just cross this 0. So, that was the negative error. So, that reading was around 5 division ok. So, that negative error was. So, minus 5 in to 0.001 least count so, that would be the error so, minus plus 0.005 ok; so, this will be added here. So, this final reading minus of minus 0.005 so, minus minus plus. So, ultimate reading will be 0.545 centimeter ok. If zero error is negative and if it is 0.005 means a fifth circular scale division line it coincide with the linear mark ok, on the linear scale ok.

So, this is the initial reading that is coming from 0 and there is the final reading. So, final minus initial that will give you the total reading so, that total reading is in this case 0.545 centimeter ok.

So, this way one can used as screw gauge basically for measuring the thickness or diameter of the very thin wire. So, this screw gauge is very useful and it gives better accuracy ok.

So, meter scale slide calipers screw gauge so, all for measuring the length ok. So, it can be diameter it can be inner depth ok, it can be diameter of cylinder it can be diameter of the wire. So, where we will use this which one? So, you have to just for. So, to reduce the error so, you have to you have to use screw gauge, when this diameter or length are of the object is very very small. So, so I think this is the basic tools for measuring the length. So, I will I will stop here.

Thank you for your kind attention.